

COMPARISON OF FINE-PARTICLE COATING AND POROSITY EFFECTS ON INFRARED SPECTROSCOPY OF SOILS IN THE FIELD AND LABORATORY. J. R. Johnson¹, P. G. Lucey¹, K. A. Horton¹, and E. M. Winter², ¹Hawaii Institute of Geophysics and Planetology, University of Hawaii at Manoa, Honolulu, HI, 96825 (jjohnson@kahana.pg.d.hawaii.edu), ²Technical Research Associates, Inc., Camarillo, CA 93010.

In our previous work [1] we studied the spectral contrast differences between apparent emissivity field spectra (8-14 μm) of undisturbed and disturbed soils and compared them to laboratory biconical reflectance spectra of wet- and dry-sieved soils. Using these preliminary data, it was suggested that the decreased spectral contrast in the reststrahlen region of disturbed soils in the field (and dry-sieved soils in the laboratory) was caused by the presence of fine-particles ($< 50 \mu\text{m}$) that adhere to larger grains after disturbance of the soil [cf. 1,2]. Undisturbed surfaces and wet-sieved samples are free of such coatings, resulting in greater spectral contrast [cf. 3,4]. Another factor influencing the spectral contrast of soils is porosity. The greater porosity of a disturbed soil can decrease spectral contrast due to multiple scattering. Here we compare the magnitude of spectral contrast effects in the field and laboratory due to fine-particle coatings and porosity for a site at Camp Lejeune, North Carolina, using updated field spectra corrected to absolute emissivity and hemispherical reflectance laboratory spectra.

Field Measurements: Field emission spectra were obtained using a Designs and Prototypes μFTIR field spectrometer [5,6] employing a MCT detector from 7-14 μm , with 16 scans co-added at a spectral resolution of approximately 6 cm^{-1} . Spectra were obtained for undisturbed, disturbed, and tamped surfaces. After the undisturbed surface was measured, it was turned over to a depth of about 25cm and given sufficient time to visibly dry before spectra were obtained. This disturbed surface was then packed down by tamping with foot pressure to restore the soil to a relatively smooth surface. Downwelling radiance spectra were also obtained by measuring the radiance collected from a diffuse reflective gold plate. Calibration of the spectra to radiance was done using blackbody measurements. Apparent emissivity spectra were obtained using a maximum-temperature method. Absolute emissivity was obtained by correcting for the downwelling radiance

component of the apparent emissivity spectra using the gold plate measurements.

Laboratory Measurements: Soil samples obtained from the measurement site were predominantly sand-sized quartz grains with variable amounts of finer clay materials. Samples were oven-dried and dry-sieved to a 53-300 μm grain size fraction. Wet-sieving to the same size fraction was done by washing the soils through sieves, followed by oven-drying.

We used a Nicolet 55XC FTIR spectrometer with an integrating sphere, coated inside with a diffusely reflecting gold surface, and a liquid nitrogen-cooled MCT detector to obtain directional hemispherical reflectance (2-14 μm) [cf. 4]. The spectrometer was configured to provide 8 cm^{-1} resolution with 1000 scans co-added per sample spectrum. Spectra were obtained for both packed and unpacked, wet- and dry-sieved samples. As shown by Salisbury et al. [3] hemispherical directional reflectance spectra can be used effectively to estimate directional emissivity via Kirchhoff's law ($\epsilon = 1 - r$). This has been done to allow better comparison between the laboratory reflectance and field emission spectra presented here.

Results: In the field spectra (Figure 1) the undisturbed site shows the deep reststrahlen bands characteristic of quartz grains in the soil. The disturbed site shows much less spectral contrast and higher emissivity in this region. The tamped surface exhibits an intermediate spectral contrast. This shows that packing, while increasing the spectral contrast, does restore the surface to its original spectral state. The calculated emissivity values from the laboratory spectra (Figure 2) show good agreement to the field data. The undisturbed and wet-sieved sample spectra both have $\epsilon = 0.60$ at 9.2 μm , and the tamped and packed, dry-sieved samples have $\epsilon = 0.75$. The disturbed ($\epsilon = 0.87$) and dry-sieved ($\epsilon = 0.82$) samples are less well correlated, probably due to residual soil moisture in the disturbed soil. Note again that the effects of packing on the dry-sieved sample do not increase

the spectral contrast to that of the wet-sieved sample.

Thus, we suggest that the decreased spectral contrast of disturbed and dry-sieved soils is dominantly the result of a difference in grain size distribution of the optically active layer (i.e., fine particle coatings). The effect of packing soils in the field and laboratory also increases spectral contrast but not to the magnitude of that observed for undisturbed and wet-sieved soils. Data from other sites across the U.S. that show similar character are reported in [2]. Since it is a common practice to use laboratory spectra of field samples to interpret spectra obtained remotely, it is our recommendation that comparisons between field and laboratory soil spectral measurements include wet- and dry-sieved soil samples in the laboratory and undisturbed and disturbed samples in the field.

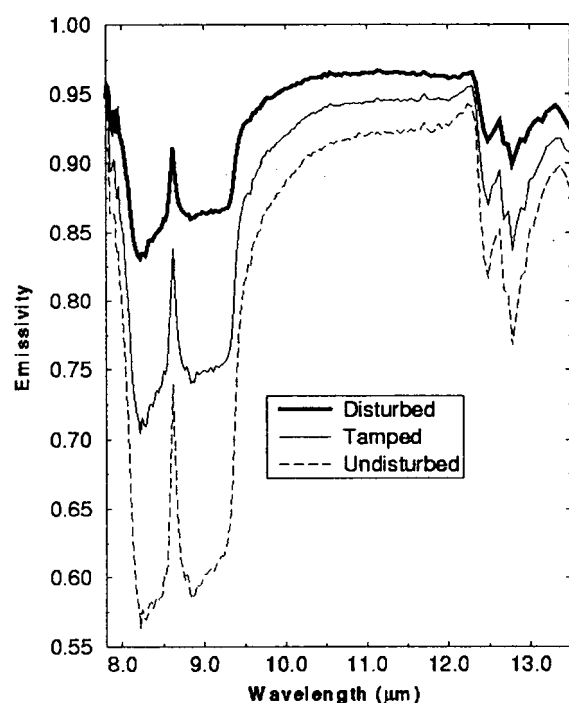


Fig. 1. Field emissivity spectra of an undisturbed, disturbed, and tamped surface at Camp Lejeune, N.C., showing decreased spectral contrast for the disturbed surface. Note also that tamping the surface does not restore the spectral contrast to that for the undisturbed surface.

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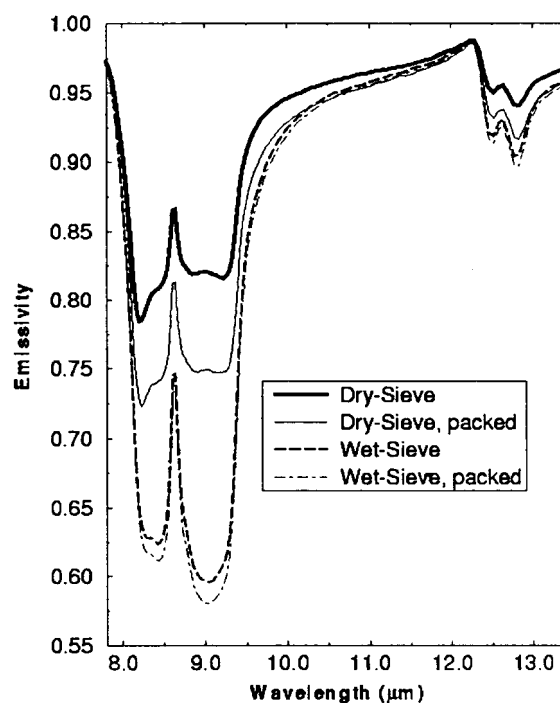


Fig. 2. Laboratory hemispherical reflectance spectra (converted to emissivity using Kirchhoff's Law) for packed and unpacked, dry- and wet-sieved 53-300 μ m samples from Camp Lejeune showing decreased spectral contrast for dry-sieved sample. Note that packing the dry-sieved sample does not increase the spectral contrast as much as wet-sieving.